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Yamamoto et al.

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(54) **PRESS-WORK METHOD AND BOTTOMED CONTAINER**

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CPC ***B21D 22/20*** (2013.01); ***B21D 22/21*** (2013.01); ***B21D 24/04*** (2013.01); ***B21D 51/02*** (2013.01); ***B21D 51/26*** (2013.01); ***B21J 5/08*** (2013.01); ***B21K 21/16*** (2013.01)

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See application file for complete search history.

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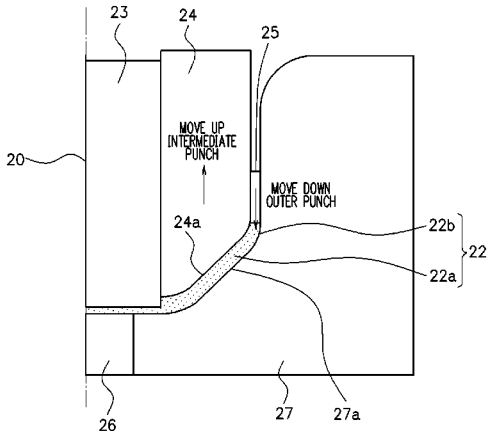
(57) **ABSTRACT**

A press mold includes an inner punch (**23**), an intermediate punch (**24**) disposed along an outer periphery of the inner punch (**23**) and having an intermediate punch inclined portion (**24***a*) at a leading end, an outer punch (**25**) disposed along an outer periphery of the intermediate punch (**24**), and a die (**27**) having a die inclined portion (**27***a*) facing the intermediate punch inclined portion (**24***a*), central axes (**20**) of all of which are coaxially disposed. While a bottom portion of a bottomed container (**22**) is constrained by the inner punch (**23**) and the die (**27**), an end portion of the bottomed container (**22**) is pressed by the outer punch (**25**), and the intermediate punch (**24**) is moved in a direction opposite a direction in which the outer punch (**25**) is pressed, whereby a bottomed container inclined portion (**22***a*) of the bottomed container (**22**) sandwiched by the intermediate punch inclined portion (**24***a*) and the die inclined portion (**27***a*) is thickened.

4 Claims, 12 Drawing Sheets



(51) **Int. Cl.**

B21J 5/08	(2006.01)
B21D 22/21	(2006.01)
B21D 24/04	(2006.01)
B21D 51/02	(2006.01)
B21D 51/26	(2006.01)

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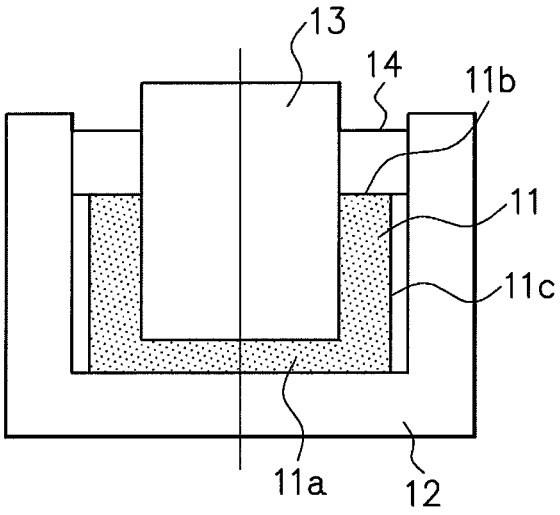
CONVENTIONAL ART

FIG. 1A



CONVENTIONAL ART

FIG. 1B

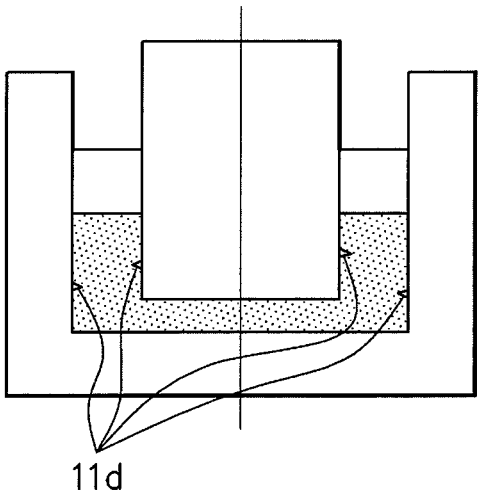


FIG. 2

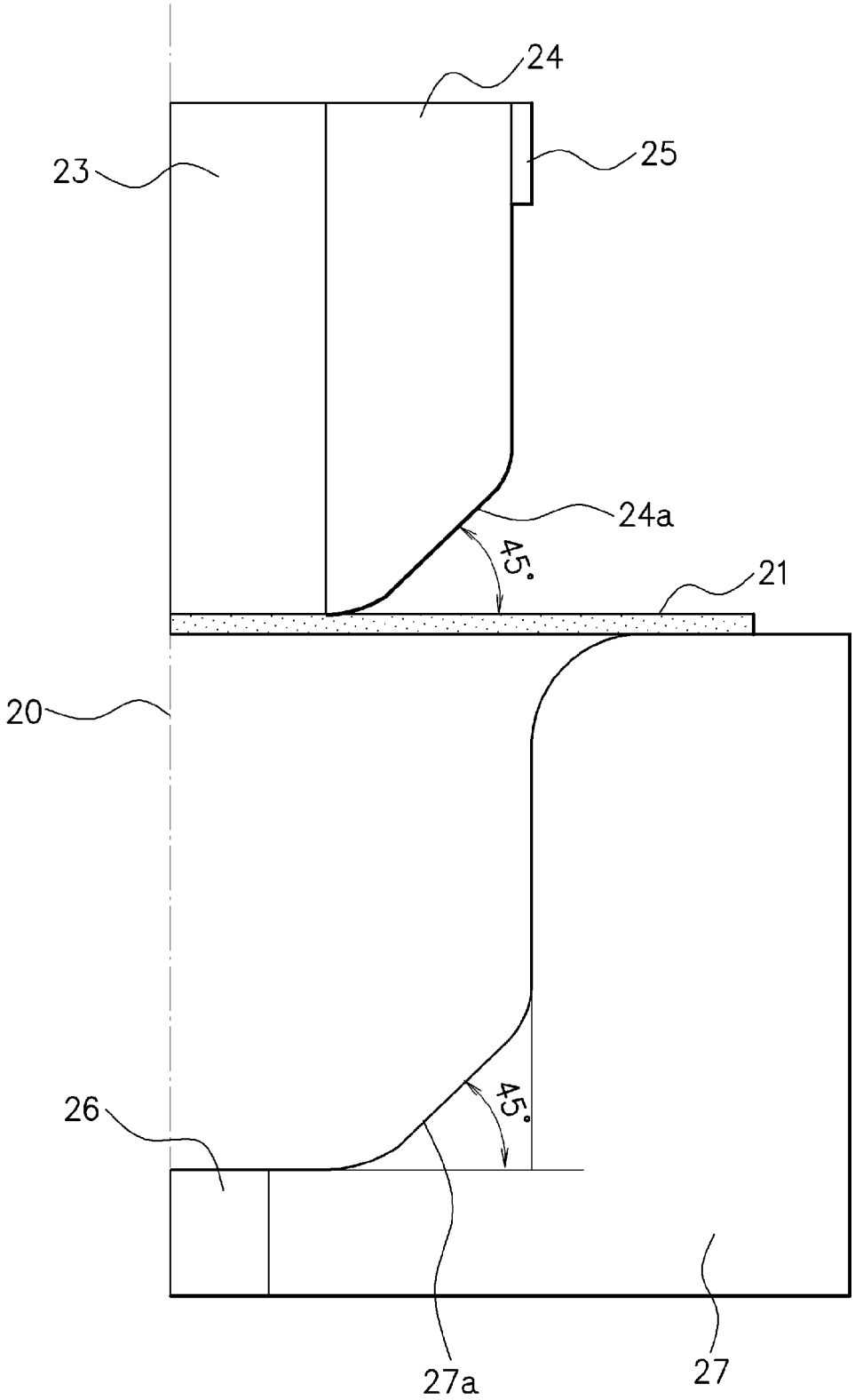


FIG. 3

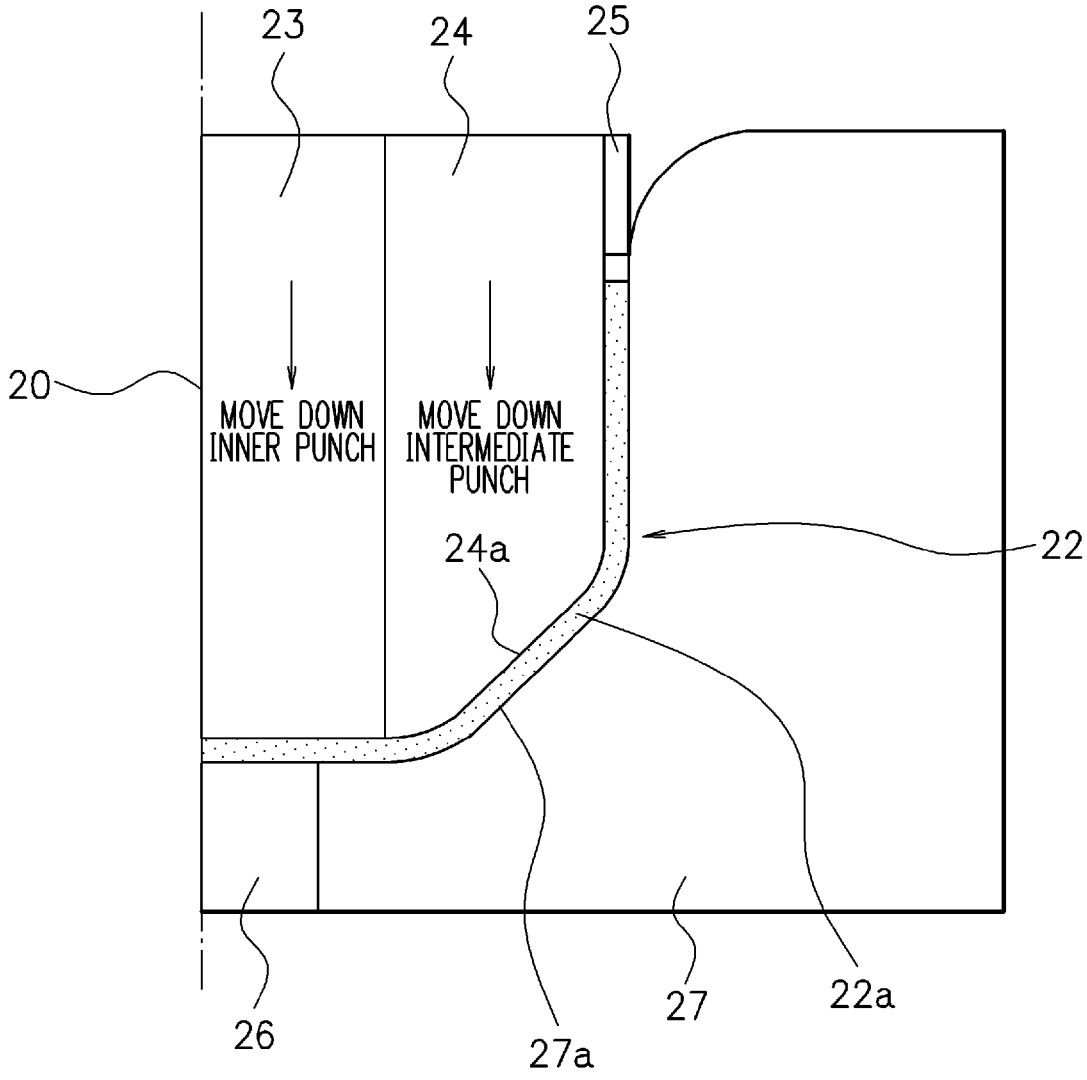

23
24
25
20
MOVE DOWN INNER PUNCH
MOVE DOWN INTERMEDIATE PUNCH
24a
22
26
27a
27
22a

FIG. 4

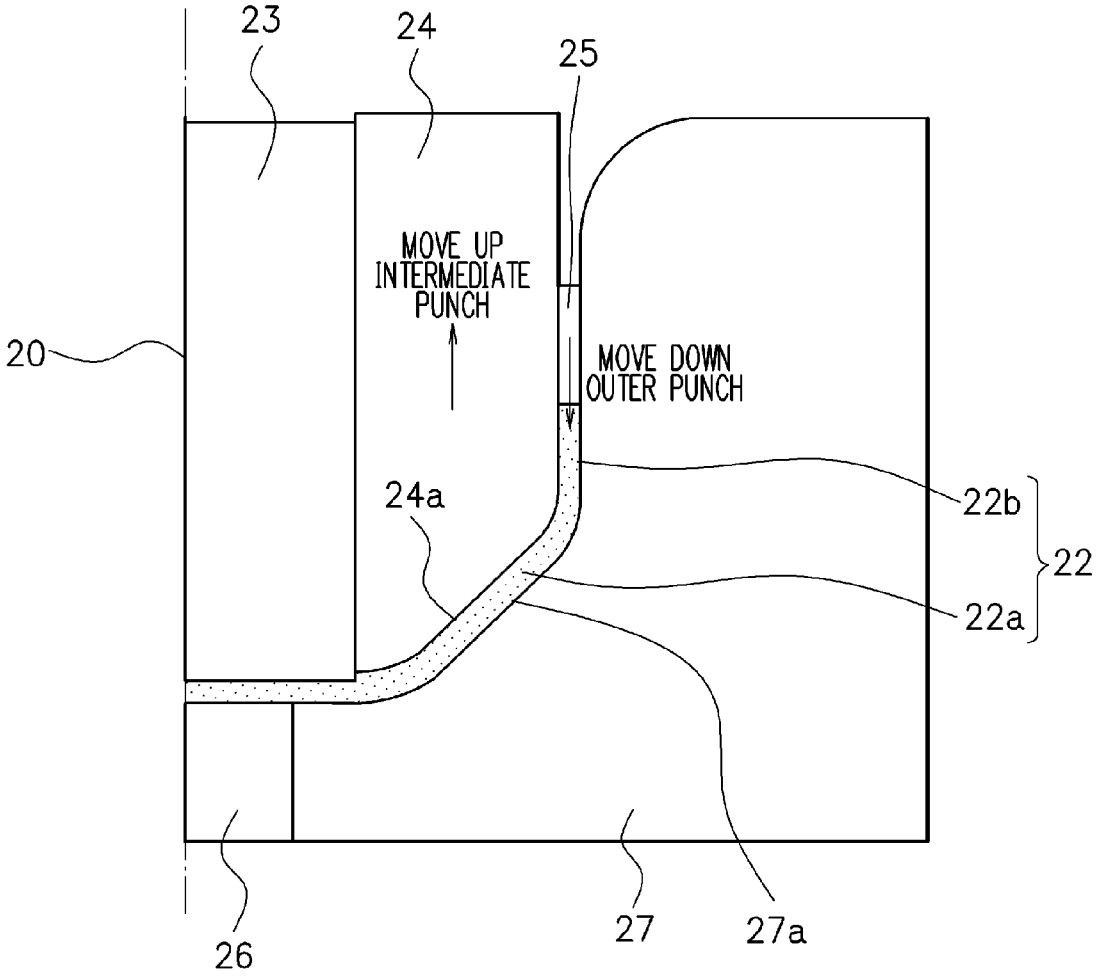

23
24
25
MOVE UP
INTERMEDIATE
PUNCH
20
MOVE DOWN
OUTER PUNCH
24a
22b
22
22a
26
27
27a

FIG. 5

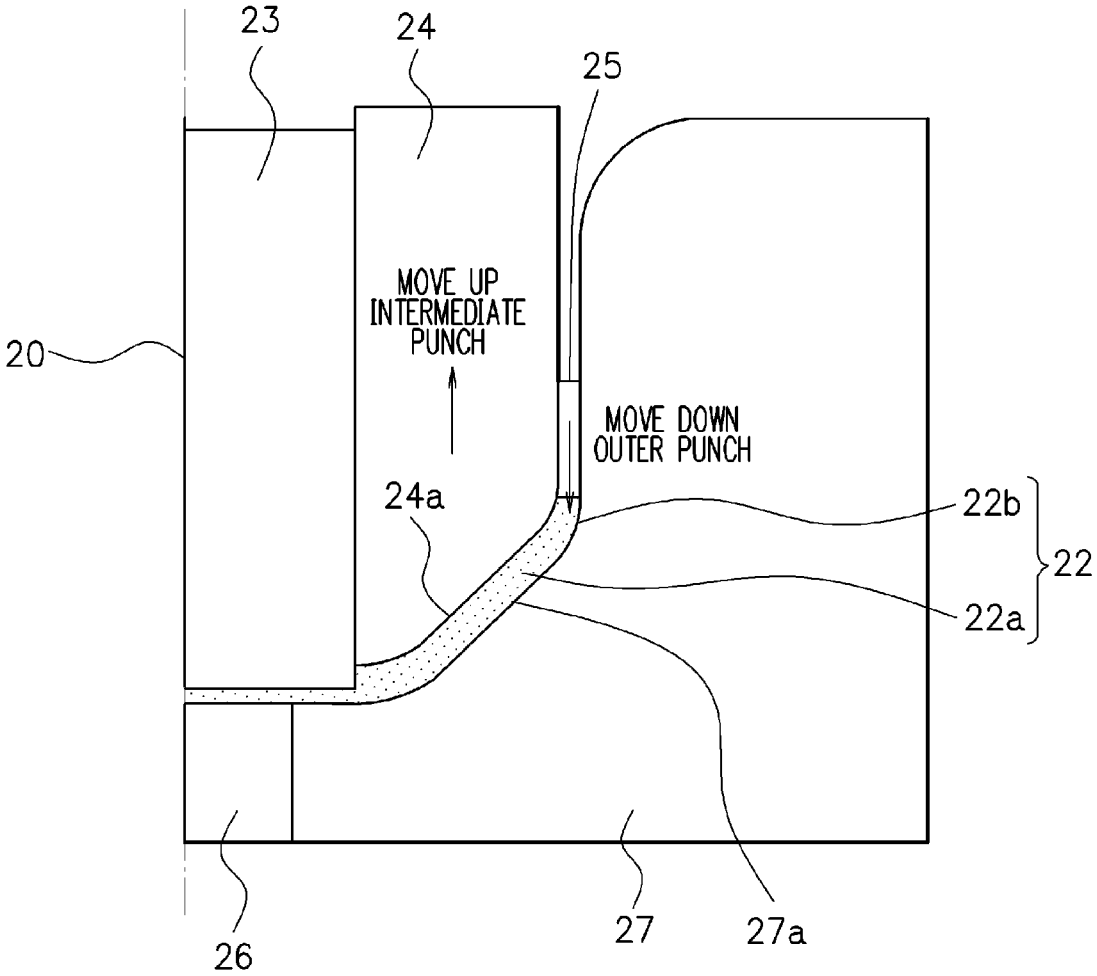

23
24
25
20
MOVE UP
INTERMEDIATE
PUNCH
MOVE DOWN
OUTER PUNCH
24a
22b
22
22a
26
27
27a

FIG. 6

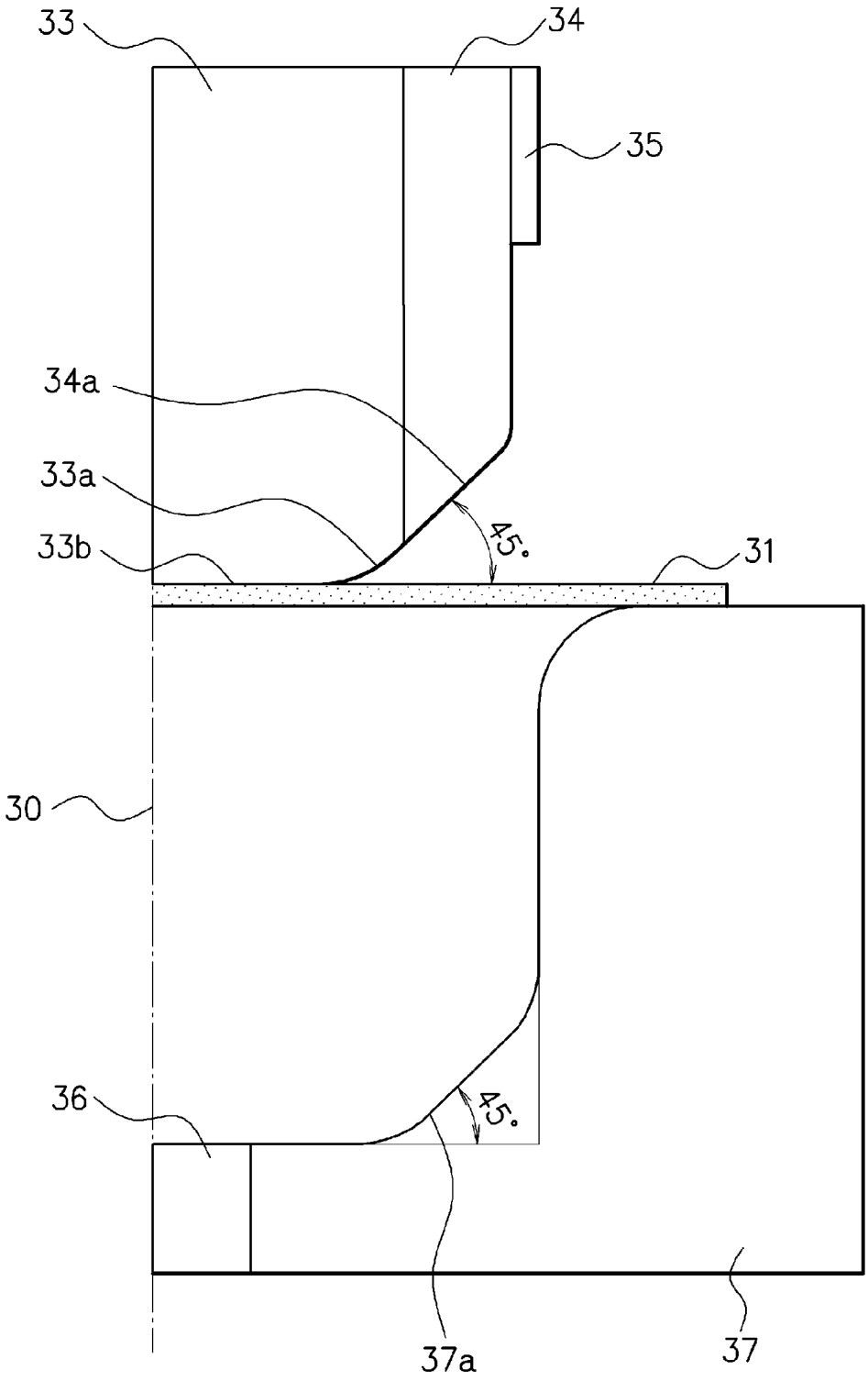


FIG. 7

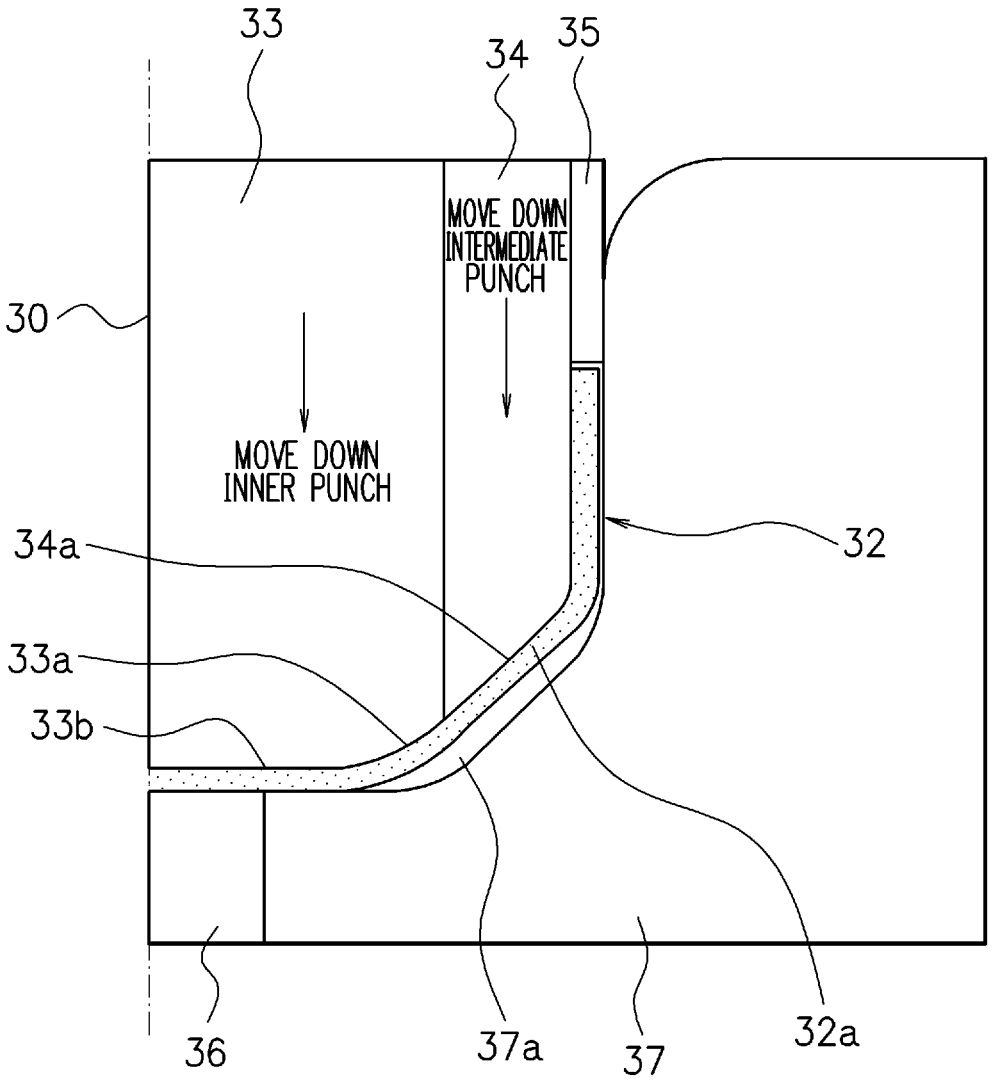

33
34
35
MOVE DOWN
INTERMEDIATE
PUNCH
30
MOVE DOWN
INNER PUNCH
34a
32
33a
33b
36
37a
37
32a

FIG. 8

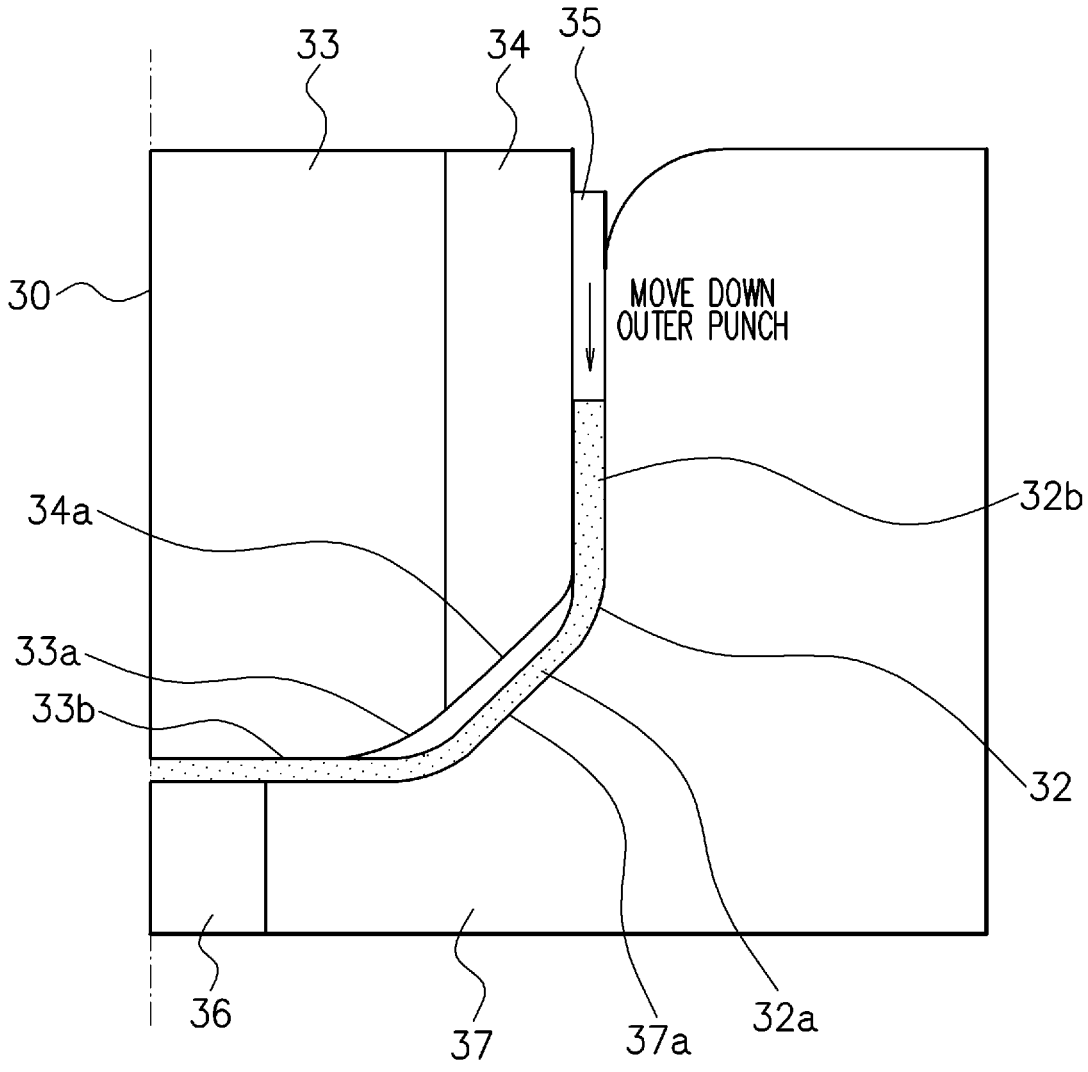

33
34
35
30
MOVE DOWN
OUTER PUNCH
34a
32b
33a
33b
32
36
37
37a
32a

FIG. 9

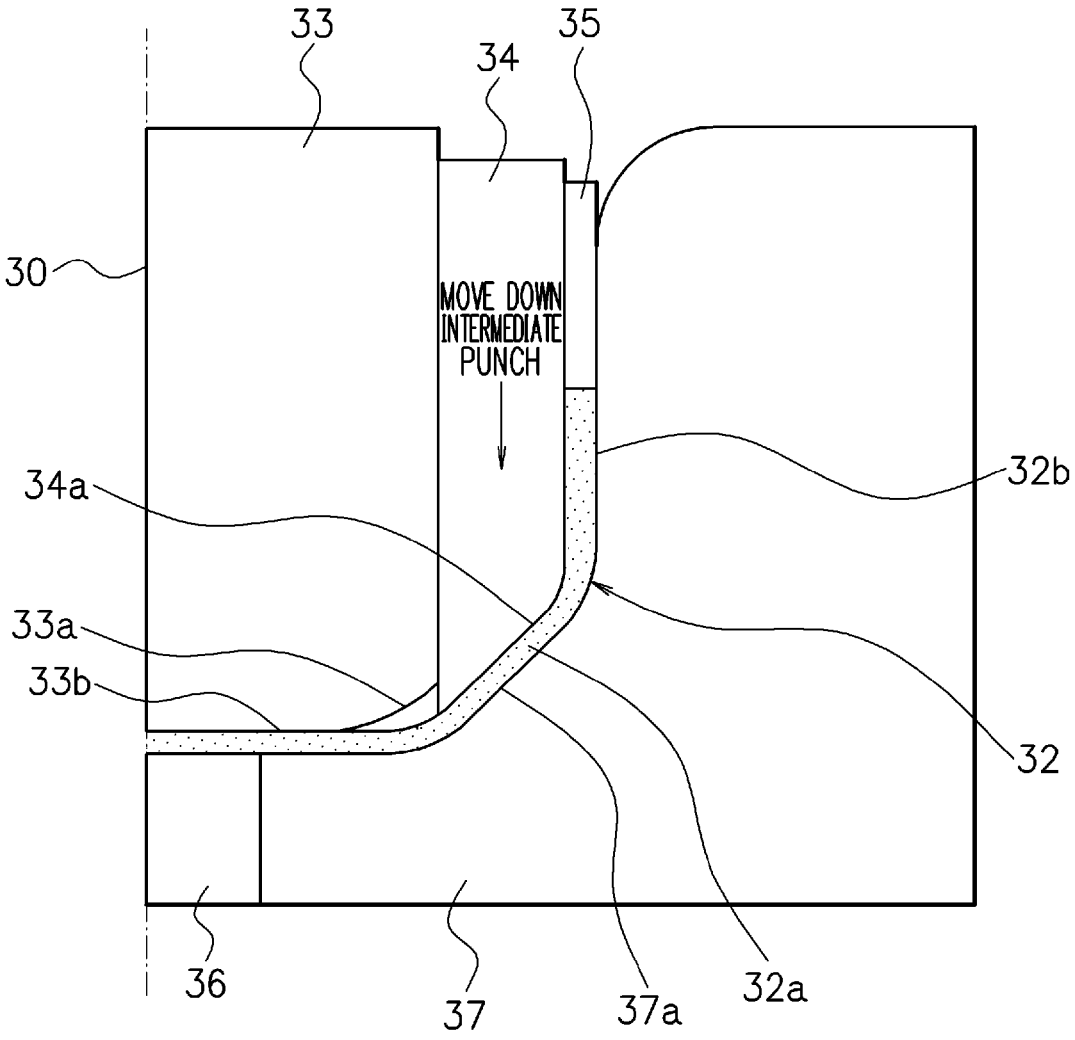

33
34
35
30
MOVE DOWN
INTERMEDIATE
PUNCH
34a
32b
33a
33b
32
36
37
37a
32a

FIG. 10

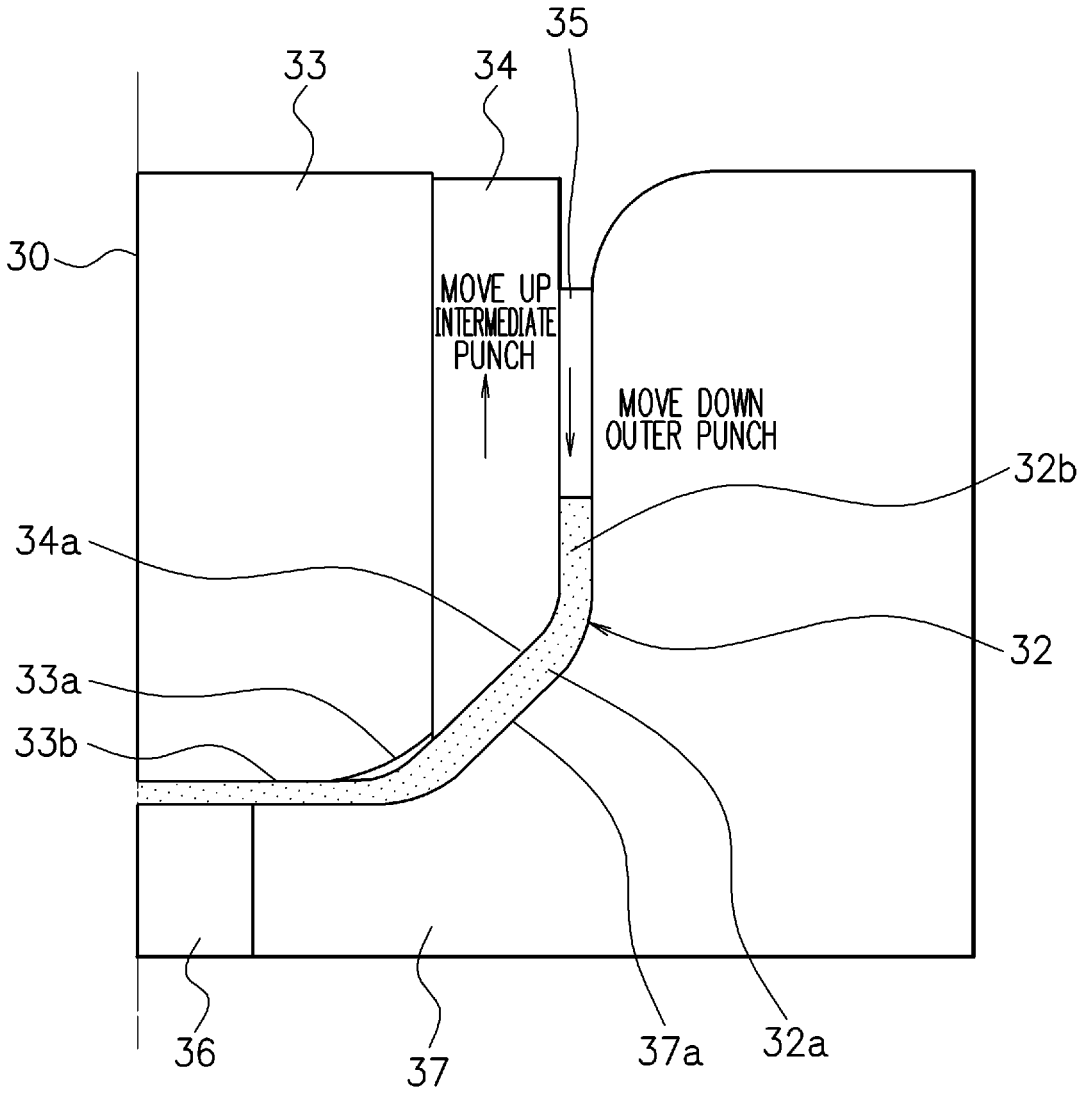

35
33
34
30
MOVE UP
INTERMEDIATE
PUNCH
MOVE DOWN
OUTER PUNCH
32b
34a
32
33a
33b
36
37
37a
32a

FIG. 11

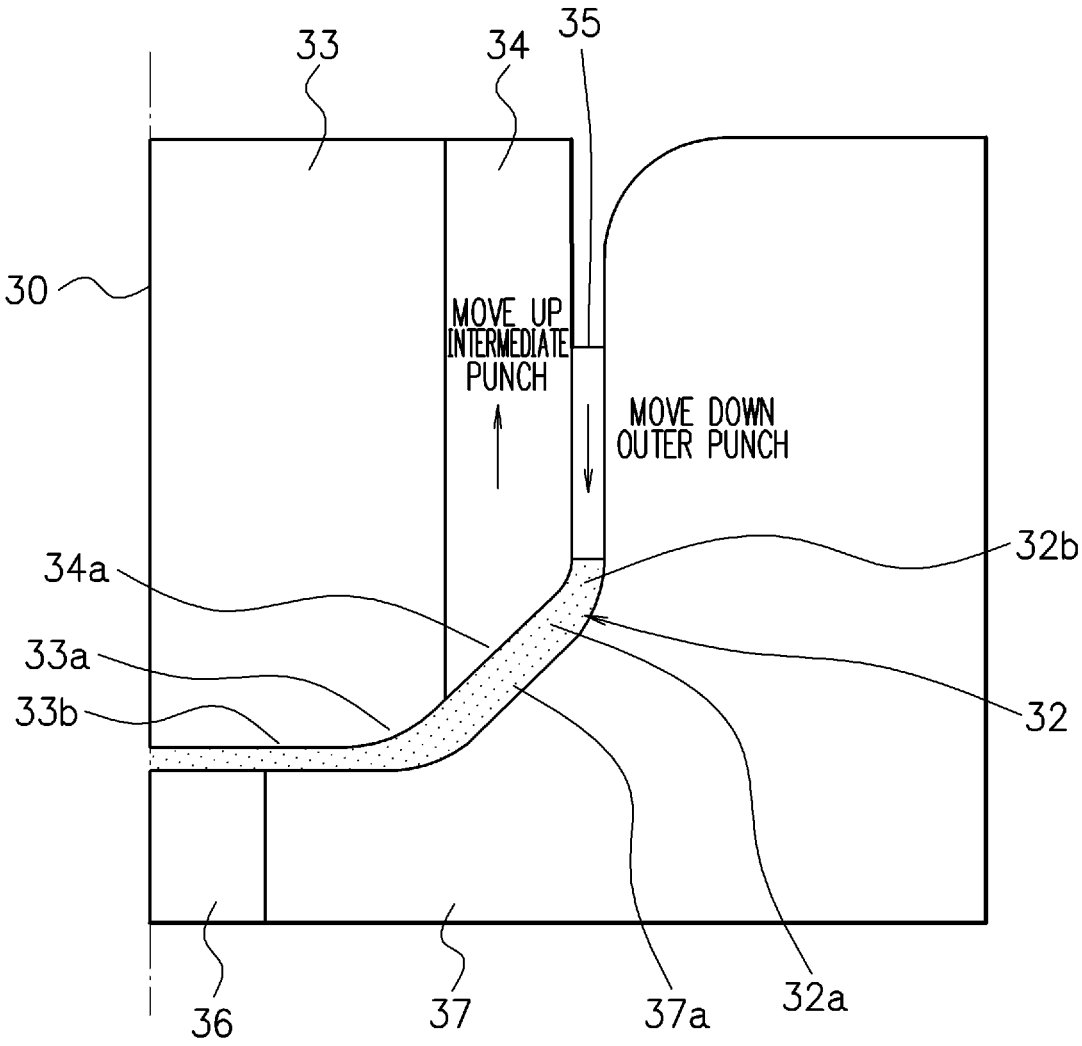
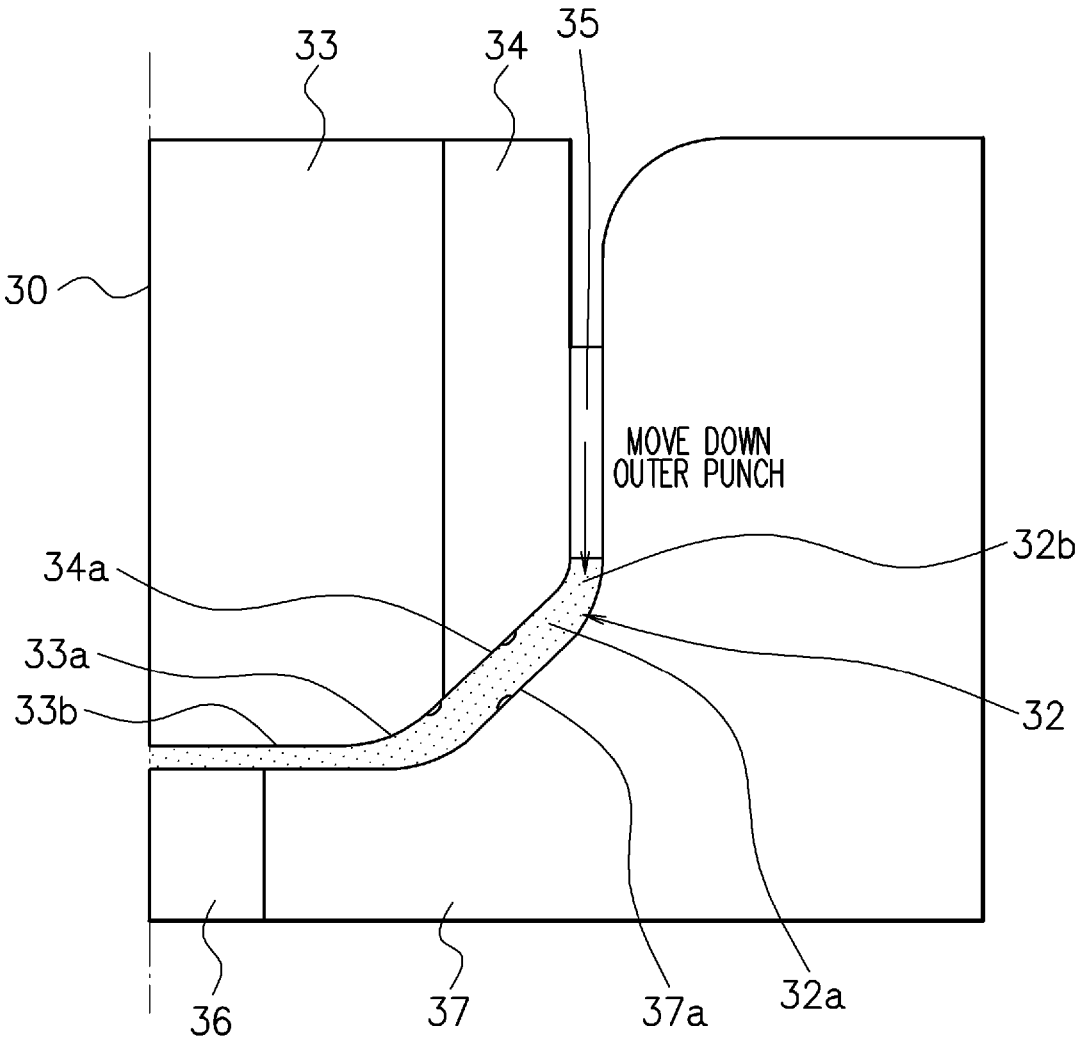

33
34
35
30
MOVE UP
INTERMEDIATE
PUNCH
MOVE DOWN
OUTER PUNCH
32b
34a
33a
33b
32
36
37
37a
32a

FIG. 12


33
34
35
30
MOVE DOWN
OUTER PUNCH
34a
32b
33a
33b
32
36
37
37a
32a

PRESS-WORK METHOD AND BOTTOMED CONTAINER

TECHNICAL FIELD

The present invention relates to a press-work method of thickening an inclined portion rising from a bottom surface portion of a bottomed container, and to a bottomed container manufactured by the same.

BACKGROUND ART

With reference to FIG. **1**A and FIG. **1**B, as a method of thickening a vertical wall of a bottomed container, a method in which a disk-shaped workpiece is formed into a bottomed container **11** by deep drawing, and an end surface **11***b* of the bottomed container is pushed by a pushing punch **14** while a bottomed container bottom surface **11***a* is sandwiched by a die **12** and a pressing punch **13**, to thereby thicken a vertical wall **11***c* of the bottomed container has been conventionally in general use. In this method, however, being constrained only weakly, the vertical wall portion of the bottomed container buckles during the thickening, so that folding **11***d* occurs. This has made it difficult to realize a large thickening ratio (sheet thickness after the thickening/original sheet thickness) exceeding 1.3.

For example, Patent Literature 1 discloses a thickening press-work method in which a pressing punch and an upsetting punch are provided, and between an upper end portion and a bottom inner portion of a workpiece, a gap is reserved between the pressing punch and a die, and an upper surface of the end portion of the workpiece is pressed by the upsetting punch. However, in the method of Patent Literature 1, folding may also occur because buckling occurs in the gap during the thickening.

Therefore, there has been proposed a method to overcome the drawbacks of the above-described thickening methods, in the manufacture of a pulley piston for continuously variable transmission of an automobile, as described in Non Patent Literature 1. This forming method is capable of preventing folding ascribable to buckling because a portion to be thickened is thickened by pushing an end portion of a cup in a state where a constraint surface of a material is increased by providing a corner portion in the portion to be thickened. However, since a gap of the portion to be thickened is geometrically decided by constraint by the shape of a mold and the movement of the mold, a maximum thickening ratio that can be achieved in one forming is about 1.5. Further, before this process, it is necessary to form a bottomed cylindrical container by deep drawing or the like, and totally two processes are required.

Further, Patent Literature 2 proposes a method in which a press-worked workpiece which has an end wall, a bent portion bent from an outer periphery of the end wall toward one side, and a cylindrical portion provided to continue from the bent portion is used, the workpiece is clamped by a clamp punch adapted to an inner surface of the workpiece, a clamp die adapted to an outer surface of the end wall, and a thickness-increase guide die fitted to an outer peripheral surface of the clamp die so as to be swingable in an axial direction and adapted to outer peripheral surfaces of the bent portion and the cylindrical portion, a thickness-increasing punch is inserted in space formed between the clamp punch and the thickness-increase guide die to apply an axial-direction compression load to the cylindrical portion, thereby thickening the bent portion, and the thickness-increase guide die is retracted from the clamp die according to the thickening.

Further, Patent Literature 3 proposes a structure in which a knockout for receiving a body portion of a workpiece, a plate presser for pressing an area up to the middle of a rising portion rising obliquely outward from the body portion, a thickness-increasing punch for pressing a tip of the rising portion, and a die for receiving the rising portion are provided, and the die is movable in an axial direction relatively to the knockout and the thickness-increasing punch. In the process of crushing the rising portion by pressing the tip of the rising portion by the thickness-increasing punch, the die is pressed by the rising portion which is in the course of being thickened without being pushed by the thickness-increasing punch, to move relatively to the knockout, so that a gap between the plate presser and the die which sandwich the rising portion widens.

However, the methods of Patent Literatures 2, 3 also require the forming of a bottomed cylindrical container by deep drawing or the like, and thus require totally two processes. Further, a cutting process is sometimes required because a large step occurs in a boundary between a thickened portion and a non-thickened portion. Further, an achievable thickening ratio is not mentioned.

Further, in the structure in which the die is divided and part thereof is moved, in Patent Literature 2, for example, a force in a direction perpendicular to an inclined portion (2*b* in Patent Literature 2) acts on the thickness-increase guide die at the time of the thickening. Since this force acts in such a direction as to make the thickness-increase guide die separate from the clamp die (outward in a diameter direction), a gap occurs in a boundary between the clamp die and the thickness-increase guide die, which may cause a burr.

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Laid-open Patent Publication No. 2001-47175

Patent Literature 2: Japanese Laid-open Patent Publication No. 2010-247199

Patent Literature 3: Japanese Laid-open Patent Publication No. 2009-248092

Non-Patent Literature

Non Patent Literature 1: "Automotive Engineering", Automotive Engineers of Japan Inc., 1996, Vol. 50, No 12, p. 31-37

SUMMARY OF INVENTION

Technical Problem

The present invention was made in order to solve the above-described conventional drawbacks and its main object is to make it possible to avoid folding due to buckling to achieve thickening with a thickening ratio of 1.5 times or more in a press-work. Its another object is to make it possible to manufacture a bottomed container having a smooth shape without a large step in a boundary between a thickened portion and a non-thickened portion. Its another object is to make it possible to manufacture a bottomed container whose inclined portion is thickened, from a disk-shaped workpiece by a press-work having one process.

Solution to Problem

The gist of the present invention that is to achieve the aforesaid objects is as follows.

[1] A press-work method using a press mold which includes an inner punch, an intermediate punch disposed along an outer periphery of the inner punch and having an intermediate punch inclined portion at a leading end, an outer punch disposed along an outer periphery of the intermediate punch, and a die having a die inclined portion facing the intermediate punch inclined portion, central axes of all of which are disposed coaxially, the method including a thickening step of, while constraining a bottom portion of a bottomed container by the inner punch and the die, pressing an end portion of the bottomed container by the outer punch and moving the intermediate punch in a direction opposite a direction in which the outer punch is pressed, to thereby thicken a bottomed container inclined portion of the bottomed container sandwiched by the intermediate punch inclined portion and the die inclined portion.

[2] A press-work method using a press mold which includes an inner punch having an inner punch flat portion and an inner punch inclined portion at a leading end, an intermediate punch disposed along an outer periphery of the inner punch and having an intermediate punch inclined portion at a leading end, an outer punch disposed along an outer periphery of the intermediate punch, and a die having a die inclined portion disposed to face the intermediate punch inclined portion, central axes of all of which are disposed coaxially, the inner punch inclined portion being formed at an end portion, of the leading end of the inner punch, on a side adjacent to the intermediate punch inclined portion, the method including:

an outer punch pressing step of, while constraining a bottom portion of a bottomed container by the inner punch flat portion and the die, pressing an end portion of the bottomed container by the outer punch to thereby bring a bottomed container inclined portion, of the bottomed container, which extends along the inner punch inclined portion and the intermediate punch inclined portion, into contact with the die inclined portion;

an intermediate punch pressing step of pressing the intermediate punch in a direction of the die against the bottomed container which is brought into contact with the die inclined portion in the outer punch pressing step, to bring the intermediate punch inclined portion into contact with the bottomed container inclined portion; and

a thickening step of pressing the outer punch against the bottomed container which is brought into contact with the intermediate punch inclined portion in the intermediate punch pressing step, and moving the intermediate punch in a direction opposite a direction in which the outer punch is pressed, to thereby thicken the bottomed container inclined portion.

[3] The press-work method according to [1], including, before the thickening step, a forming step of pressing a disk-shaped workpiece into the die by the inner punch and the intermediate punch to form the bottomed container in which the bottomed container inclined portion is formed at a position sandwiched by the intermediate punch inclined portion and the die inclined portion.

[4] The press-work method according to [2], including, before the outer punch pressing step, a forming step of pressing a disk-shaped workpiece into the die by the inner punch and the intermediate punch to form the bottomed container in which the bottomed container inclined portion is formed at a position sandwiched by the inner punch inclined portion and the intermediate punch inclined portion, and the die inclined portion.

[5] The bottomed container manufactured by the press-work method according to [1], wherein a thickening ratio of a thickness of the bottomed container inclined portion is 1.5 times or more.

[6] The bottomed container manufactured by the press-work method according to [2], wherein a thickening ratio of a thickness of the bottomed container inclined portion is 1.5 times or more.

Advantageous Effects of Invention

According to the present invention, it is possible to avoid folding due to buckling to achieve thickening with a thickening ratio of 1.5 times or more.

Further, it is possible to manufacture a bottomed container having a smooth shape without a large step in a boundary between a thickened portion and a non-thickened portion.

Furthermore, it is possible to manufacture a bottomed container whose inclined portion is thickened, from a disk-shaped workpiece by a press-work having one process.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1**A is a cross-sectional view illustrating a conventional thickening work.

FIG. **1**B is a cross-sectional view illustrating the conventional thickening work.

FIG. **2** is a cross-sectional view illustrating a state before deep drawing in a press-work method according to a first embodiment.

FIG. **3** is a cross-sectional view illustrating a state after the deep drawing in the press-work method according to the first embodiment.

FIG. **4** is a cross-sectional view illustrating a state in the middle of thickening in the press-work method according to the first embodiment.

FIG. **5** is a cross-sectional view illustrating a state after the thickening in the press-work method according to the first embodiment.

FIG. **6** is a cross-sectional view illustrating a state before deep drawing in a press-work method according to a second embodiment.

FIG. **7** is a cross-sectional view illustrating a state after the deep drawing in the press-work method according to the second embodiment.

FIG. **8** is a cross-sectional view illustrating a state where an inclined portion of a die is brought into contact with an inclined portion of a bottomed container in the press-work method according to the second embodiment.

FIG. **9** is a cross-sectional view illustrating a state where an inclined portion of an intermediate punch is brought into contact with the inclined portion of the bottomed container in the press-work method according to the second embodiment.

FIG. **10** is a cross-sectional view illustrating a state in the middle of thickening in the press-work method according to the second embodiment.

FIG. **11** is a cross-sectional view illustrating a state after the thickening in the press-work method according to the second embodiment.

FIG. **12** is a cross-sectional view illustrating a comparative example of the second embodiment.

DESCRIPTION OF EMBODIMENTS

Hereinafter, modes for carrying out the present invention will be described with reference to the attached drawings.

As a result of studious studies, the present inventor has found out that, by performing deep drawing by using an inner punch, an intermediate punch disposed along an outer periphery of the inner punch, and a die, central axes of all of which are coaxially disposed, to form a bottomed container, and subsequently, while constraining a workpiece, performing thickening by gradually increasing a gap between the intermediate punch and the die when an end surface of the bottomed container is pressed by the outer punch, it is possible to perform the thickening with a thickening ratio of 1.5 times or more by a press-work having one process while avoiding folding due to buckling.

(First Embodiment)

FIG. **2** is a cross-sectional view illustrating a state before deep drawing is executed. As illustrated in FIG. **2**, a press mold includes an inner punch **23**, an intermediate punch **24** disposed along an outer periphery of the inner punch **23**, an outer punch **25** disposed along an outer periphery of the intermediate punch **24**, a knockout **26**, and a die **27** disposed along an outer periphery of the knockout **26**, central axes of all of which are coaxially disposed. The inner punch **23** is disposed to face the knockout **26** and the die **27**, and the intermediate punch **24** and the outer punch **25** are disposed to face the die **27**.

The inner punch **23** has a columnar shape, and is of a movable type capable of moving up and down by a not-illustrated drive source of a mechanical type (hydraulic or servo motor, or the like).

The intermediate punch **24** has a cylindrical shape, and on its surface that comes into contact with a portion to be thickened of a workpiece (that is, on a lower end portion (leading end) of the intermediate punch **24**), an intermediate punch inclined portion **24***a* is formed. This intermediate punch inclined portion **24***a* is inclined in an obliquely upward direction from an inner punch **23** side toward an outer punch **25** side. The intermediate punch **24** is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

The outer punch **25** has a cylindrical shape and is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

The knockout **26** has a columnar shape, is intended to detach a formed product from the mold, and is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

The die **27** is of a fixed type, has a substantially concave shape, and has, at a center portion, a hole allowing the knockout **26** to be inserted therein. Further, in the die **27**, a die inclined portion **27***a* is formed, and this die inclined portion **27***a* is disposed to face the intermediate punch inclined portion **24***a*.

In this embodiment, by executing the following forming step and thickening step, the workpiece **21** was press-worked. As the workpiece **21**, a disk-shaped high-tensile steel sheet (SAPH590) having a 240 mm outside diameter and a 4 mm sheet thickness was used.

The workpiece **21** is placed on the die **27** and is subjected to the deep drawing by pressing the inner punch **23** and the intermediate punch **24**, whereby a bottomed container **22** in which a bottomed container inclined portion **22***a* is formed at a position sandwiched by the intermediate punch inclined portion **24***a* and the die inclined portion **27***a* is formed as illustrated in FIG. **3** (forming step).

In the state illustrated in FIG. **3**, a bottom portion of the bottomed container **22** is constrained by the inner punch **23** and the die **27**.

Subsequently, as illustrated in FIG. **4** and FIG. **5**, an end surface of the bottomed container **22** formed in the forming step is pressed by the outer punch **25**, and the intermediate punch **24** is moved upward. Consequently, a gap between the intermediate punch inclined portion **24***a* and the die inclined portion **27***a* gradually becomes larger, which makes it possible to perform the thickening while suppressing buckling by sandwiching the bottomed container inclined portion **22***a* by the intermediate punch inclined portion **24***a* and the die inclined portion **27***a* (thickening step). The cross-sectional views in FIG. **4** and FIG. **5** illustrate states in the middle of the thickening and after the thickening respectively.

After the thickening step, the inner punch **23**, the intermediate punch **24**, the outer punch **25**, and the knockout **26** are moved upward, and the bottomed container **22** is detached from the die **27**. A sheet thickness of the bottomed container inclined portion **22***a* is 6.9 mm, and thus the thickness can be increased to 1.73 times an original sheet thickness of 4 mm without any occurrence of folding due to buckling.

Further, at the time of the thickening, a force in a direction perpendicular to the intermediate punch inclined portion **24***a* acts on the intermediate punch **24**, but since this force acts in such a direction as to press the intermediate punch **24** against the inner punch **23** (inward in a diameter direction (center direction)), there occurs no gap in a boundary between the inner punch **23** and the intermediate punch **24** and a burr is not generated.

(Second Embodiment)

In a second embodiment, a bottomed container having a smooth shape without a large step in a boundary between a thickened portion and a non-thickened portion is manufactured.

FIG. **6** is a cross-sectional view illustrating a state before deep drawing is executed. As illustrated in FIG. **6**, a press mold includes an inner punch **33**, an intermediate punch **34** disposed along an outer periphery of the inner punch **33**, an outer punch **35** disposed along an outer periphery of the intermediate punch **34**, a knockout **36**, and a die **37** disposed along an outer periphery of the knockout **36**, central axes **30** of all of which are coaxially disposed. The inner punch **33** is disposed to face the knockout **36** and the die **37**, and the intermediate punch **34** and the outer punch **35** are disposed to face the die **37**.

The inner punch **33** has a columnar shape, and on its leading end, an inner punch inclined portion **33***a* and an inner punch flat portion **33***b* are formed. The inner punch inclined portion **33***a* is formed on a peripheral edge portion of the leading end, that is, on an end portion on a side adjacent to an intermediate punch inclined portion **34***a*, and the inner punch flat portion **33***b* is formed around the central axis **30**. The inner punch inclined portion **33***a* is inclined in an obliquely upward direction from a central axis **30** side toward an intermediate punch **34** side. The inner punch flat portion **33***b* extends in a horizontal direction perpendicular to the central axis **30**. The inner punch **33** is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

The intermediate punch **34** has a cylindrical shape, and on its surface that comes into contact with a portion to be thickened of a workpiece (that is, on a lower end portion (leading end) of the intermediate punch **34**), the intermediate punch inclined portion **34***a* is formed. This intermediate punch inclined portion **34***a* is inclined in an obliquely upward direction from an inner punch **33** side toward an outer punch **35**

side. The intermediate punch **34** is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

Here, when a height of an end portion of the inner punch inclined portion **33***a* on a side more distant from the central axis **30** and a height of an end portion of the intermediate punch inclined portion **34***a* on a side closer to the central axis **30** are equal, that is, in the state illustrate in FIG. **6**, the inner punch inclined portion **33***a* and the intermediate punch inclined portion **34***a* form a smooth curve.

The outer punch **35** has a cylindrical shape and is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

The knockout **36** has a columnar shape, is intended to detach a formed product from the mold, and is of a movable type capable of moving up and down by a not-illustrated mechanical drive source.

The die **37** is of a fixed type, has a substantially concave shape, and has, at a center portion, a hole allowing the knockout **36** to be inserted therein. In the die **37**, a die inclined portion **37***a* is formed, and this die inclined portion **37***a* is disposed to face the inner punch inclined portion **33***a* and the intermediate punch inclined portion **34***a*.

In this embodiment, by executing the following forming step, outer punch pressing step, intermediate punch pressing step, and thickening step, the workpiece **31** was press-worked. As the workpiece **31**, a disk-shaped high-tensile steel sheet (SAPH590) having a **224** outside diameter and a 4 mm sheet thickness was used.

The workpiece **31** is placed on the die **37**, and is subjected to the deep drawing by pressing the inner punch **33** and the intermediate punch **34**, whereby a bottomed container **32** in which a bottomed container inclined portion **32***a* is formed at a position sandwiched by the inner punch inclined portion **33***a* and the intermediate punch inclined portion **34***a*, and the die inclined portion **37***a* is formed as illustrated in FIG. **7** (forming step).

In the state illustrated in FIG. **7**, a bottom portion of the bottomed container **32** is constrained by the inner punch flat portion **33***b* of the inner punch **33** and the die **37**.

Subsequently, an end surface of the bottomed container **32** formed in the forming step is pressed by the outer punch **35**, whereby the bottomed container inclined portion **32***a* extending along the inner punch inclined portion **33***a* and the intermediate punch inclined portion **34***a* is brought into contact with the die inclined portion **37***a* as illustrated in FIG. **8** (outer punch pressing step).

Subsequently, the intermediate punch **34** is moved downward toward the bottomed container **32** which is brought into contact with the die **37** in the outer punch pressing step (the intermediate punch **34** is pressed toward the die **37**), whereby the intermediate punch inclined portion **34***a* is brought into contact with the bottomed container inclined portion **32***a* as illustrated in FIG. **9** (intermediate punch pressing step).

Subsequently, as illustrated in FIG. **10** and FIG. **11**, an end surface of the bottomed container **32** is pressed by the outer punch **35**, and the intermediate punch **34** is moved upward. Consequently, a gap between the intermediate punch inclined portion **34***a* and the die inclined portion **37***a* gradually becomes larger, which makes it possible to perform the thickening while suppressing buckling by sandwiching the bottomed container inclined portion **32***a* by the intermediate punch inclined portion **34***a* and the die inclined portion **37***a* (thickening step). The cross-sectional views in FIG. **10** and FIG. **11** illustrate states in the middle of the thickening and after the thickening respectively.

After the thickening step, the inner punch **33**, the intermediate punch **34**, the outer punch **35**, and the knockout **36** are moved upward, and the bottomed container **32** is detached from the die **37**. A sheet thickness of the bottomed container inclined portion **32***a* is 8 mm, and thus the thickness can be increased to twice an original sheet thickness of 4 mm without any occurrence of folding due to buckling. Further, a smooth shape is achieved without any large step in a boundary between a thickened portion and a non-thickened portion.

Further, at the time of the thickening, a force in a direction perpendicular to the intermediate punch inclined portion **34***a* acts on the intermediate punch **34**, but since this force acts in such a direction as to press the intermediate punch **34** against the inner punch **33** (inward in a diameter direction (center direction)), there occurs no gap in a boundary between the inner punch **33** and the intermediate punch **34** and a burr is not generated.

Here, in the state illustrated in FIG. **7**, if the end portion of the bottomed container **32** is pressed by the outer punch **35** without the intermediate punch **34** abutting on the bottomed container **32**, the bottomed container inclined portion **32***a* is not sufficiently constrained, and accordingly, buckling occurs in the bottomed container inclined portion **32***a* as illustrated in FIG. **12**. Therefore, by executing the thickening process by the outer punch **35** while constraining the bottomed container inclined portion **32***a* by sandwiching it by the intermediate punch **34** and the die **37**, it is possible to suppress the buckling in the bottomed container inclined portion **32***a*.

In the above-described examples, an angle made by the bottomed container inclined portions **22***a*, **32***a* and the horizontal direction is 45°, but it is desirably not less than 20° nor more than 70°. This is because, if the angle made by the bottomed container inclined portion **22***a*, **32***a* and the horizontal direction is less than 20°, a flow of a material from bottomed container vertical wall portions **22***b*, **32***b* to the bottomed container inclined portions **22***a*, **32***a* becomes worse, and a load required for the forming becomes large. Further, this is because, if the angle made by the bottomed container inclined portions **22***a*, **32***a* and the horizontal direction is over 70°, a contact length of the workpieces **21**, **31** and the mold becomes long, and accordingly a frictional force becomes large, so that a load required for the forming becomes large. Note that the bottomed container vertical wall portions **22***b*, **32***b* mean portions of the bottomed containers **22**, **32** on a side closer to the outer punches **25**, **35** than the bottomed container inclined portions **22***a*, **32***a*.

Hitherto, the present invention has been described together with various embodiments, but the present invention is not limited only to these embodiments, and changes and so on can be made within the scope of the present invention.

In the above-described examples, SAPH590 is used as the workpiece, but it is not limited to an iron-based material, but an aluminum-based metal, a titanium-based metal, or the like is usable.

Further, in the above-described embodiments, the examples where the bottomed container whose inclined portion is thickened is manufactured from the disk-shaped workpiece by the press-work having one process, but the present invention is also applicable to a press-work whose thickening target is a bottomed container having an inclined portion which is formed in a separate process, that is, to a press-work whose starting state is FIG. **3** or FIG. **7**.

INDUSTRIAL APPLICABILITY

The present invention is usable for thickening an inclined portion rising from a bottom surface portion of a bottomed container.

The invention claimed is:

1. A press-work method using a press mold which includes an inner punch, an intermediate punch disposed along an outer periphery of the inner punch and having an intermediate punch inclined portion at a leading end, an outer punch disposed along an outer periphery of the intermediate punch, and a die having a die inclined portion facing the intermediate punch inclined portion, central axes of all of which are disposed coaxially, the method comprising

a thickening step of, while constraining a bottom portion of a bottomed container by the inner punch and the die, pressing an end portion of the bottomed container by the outer punch and moving the intermediate punch in a direction opposite a direction in which the outer punch is pressed, to thereby thicken a bottomed container inclined portion of the bottomed container sandwiched by the intermediate punch inclined portion and the die inclined portion.

2. The press-work method according to claim 1, comprising, before the thickening step, a forming step of pressing a disk-shaped workpiece into the die by the inner punch and the intermediate punch to form the bottomed container in which the bottomed container inclined portion is formed at a position sandwiched by the intermediate punch inclined portion and the die inclined portion.

3. A press-work method using a press mold which includes an inner punch having an inner punch flat portion and an inner punch inclined portion at a leading end, an intermediate punch disposed along an outer periphery of the inner punch and having an intermediate punch inclined portion at a leading end, an outer punch disposed along an outer periphery of the intermediate punch, and a die having a die inclined portion disposed to face the intermediate punch inclined portion, central axes of all of which are disposed coaxially, the inner punch inclined portion being formed at an end portion, of the leading end of the inner punch, on a side adjacent to the intermediate punch inclined portion, the method comprising:

an outer punch pressing step of, while constraining a bottom portion of a bottomed container by the inner punch flat portion and the die, pressing an end portion of the bottomed container by the outer punch to thereby bring a bottomed container inclined portion, of the bottomed container, which extends along the inner punch inclined portion and the intermediate punch inclined portion, into contact with the die inclined portion;

an intermediate punch pressing step of pressing the intermediate punch in a direction of the die against the bottomed container which is brought into contact with the die inclined portion in the outer punch pressing step, to bring the intermediate punch inclined portion into contact with the bottomed container inclined portion; and

a thickening step of pressing the outer punch against the bottomed container which is brought into contact with the intermediate punch inclined portion in the intermediate punch pressing step, and moving the intermediate punch in a direction opposite a direction in which the outer punch is pressed, to thereby thicken the bottomed container inclined portion.

4. The press-work method according to claim 3, comprising, before the outer punch pressing step, a forming step of pressing a disk-shaped workpiece into the die by the inner punch and the intermediate punch to form the bottomed container in which the bottomed container inclined portion is formed at a position sandwiched by the inner punch inclined portion and the intermediate punch inclined portion, and the die inclined portion.

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